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A quantum computer in the scheme of an atomic quantum transistor with logical encoding of qubits

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Abstract

A scheme of a multiqubit quantum computer on atomic ensembles using a quantum transistor implementing two qubit gates is proposed. We demonstrate how multiatomic ensembles permit one to work with a large number of qubits that are represented in a logical encoding in which each qubit is recorded on a superposition of single-particle states of two atomic ensembles. The access to qubits is implemented by appropriate phasing of quantum states of each of atomic ensembles. An atomic quantum transistor is proposed for use when executing two qubit operations. The quantum transistor effect appears when an excitation quantum is exchanged between two multiatomic ensembles located in two closely positioned QED cavities connected with each other by a gate atom. The dynamics of quantum transfer between atomic ensembles can be different depending on one of two states of the gate atom. Using the possibilities of control for of state of the gate atom, we show the possibility of quantum control for the state of atomic ensembles and, based on this, implementation of basic single and two qubit gates. Possible implementation schemes for a quantum computer on an atomic quantum transistor and their advantages in practical implementation are discussed.

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